

Water Resources: Hydraulics and Hydrology

A: Yes. He was, let's see, he's the one, did he come in from North Central Division?

Q: I'll have to check.

A: Well, anyhow, he's the one in that picture.

Q: Your retirement picture?

A: On the St. Lawrence, which meant he was division engineer up in Chicago.

Q: He's also in your retirement picture with you.

A: Oh, wait a minute now. I'm confused--Bachus was the man.

Q: Walt Bachus?

A: Yes, in Chicago. Leber was the one that gave me--he was from ORD and the Deputy Chief then, wasn't he?

Q: He was the Director of Civil Works.

A: Oh, yes, that's right, yes. That was my retirement.

Q: Right.

A: I'm trying to think. Some of the Chiefs, after they've been Chief of Engineers and head the Mississippi River Commission, they end up as Governor of the Panama Canal. One of the ones that I knew was down at the Panama Canal when Mary and I were down there on a trip. We stopped in Panama City for a few days.

Q: I think Potter was.

A: Probably was, because it was somebody I felt that I knew well enough to make a contact.

Q: I think it was Potter.

A: Yes. We were probably on our way to Bogota. I had a half a dozen consulting jobs in Bogota. Ingitec was the name of the engineering company.

Q: Well, I'll check that.

A: Well, anyhow, I called the Canal office and the Governor was away, but whoever was acting for him was very friendly-and it may have been somebody I knew, too. We were invited to some reception they were giving. I always remember that.

Major Projects

Q: Do you remember any of the major projects besides the St. Lawrence that you may have worked on?

A: Well, of course, the Pick-Sloan.

Q: We talked about that. Those were a lot of large pieces of work there, Garrison and Oahe.

A: Yes, I remember those were tremendous projects. And, well, of course, the Columbia River. Los Angeles always had a lot of projects in the mill for their flood control, and after they authorized water supply in Corps' reservoirs, they started putting water supply in some of the projects.

Q: Did those flood control dams in Los Angeles present a problem because they were dry most of the year?

A: Yes.

Q: Did they cause you more difficulties to forecast those things because of the runoff and the nature of the terrain?

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A: Well, I don't know. The big problem was the debris. In other words, whenever they had a heavy storm in those gullies and everything, the debris was always a major concern. It's pretty hard to predict how much of that you're going to get when *designing them and during operations. Generally, I guess, in their life, there was enough allowance for it and it hadn't really caused too much trouble. I suppose as time goes on, and maybe even now, some of them have been filled up quite a bit.

Q: I think they clean them out all of the time.

A: Yes, some of them which are primarily debris dams. Since they're dry part of the year, why they can do that. On some of the dams I worked overseas on, it was always a concern as to how much reserve capacity was needed. Some of them they tried to design so that at a certain time of the year, they would let a fair amount of water through the lower conduits and try to get rid of a lot of the sediment. There was always an argument whether you could accomplish that or not.

Q: I was going to ask you about the problem of contaminants or polluted materials in the sediment in the dam because that's something that Verne Hagen talked about becoming a problem for the Corps during the environmental era. But when you figured, you were doing your estimates, how much did sediment figure into your calculations on regulating the reservoirs?

A: Well, there were fairly definite criteria. Of course, I don't mean as to estimating. They had to use procedures. I don't mean that those procedures were definite as to estimating the amount of the sediment. But having made an estimate, well then the requirements for providing space for it were pretty clean cut and everything so that the design just went ahead.

Another project that Hathaway pushed was to get the Corps and other agencies that had dams to establish permanent surveying facilities so they could measure the amount of sediment that was actually deposited in the various projects. I'm sure the Corps is still doing that periodically. The subcommittee on sedimentation coordinated the program and has published a number of reports. As each dam was surveyed, why the data would be compiled and published. That was a major activity of the sub-committee on sedimentation. Hathaway was one that was able to make sure that the field offices would establish the markers and do these surveys from time-to-time. It took money to do it, and they'd have to budget for it.

Q: Did Hathaway have very good contacts in the Congress? I mean on the staffs of the committees? Did he have really good contacts?

A: No, I don't think he worked on that end of it very much. That was up to Tofani and the others. I don't know whether Hathaway did any Congressional work. In the beginning when we asked for these funds for installing the recording rain gauges all over the country, setting up the hydro-met section in the Weather Bureau to develop our probable maximum storms, and transferring funds to the Geological Survey for installing and operating stream gauging stations, he certainly sold the Chief's Office on it. He probably testified in the beginning when I wasn't knowledgeable, but I don't recall him getting involved. He would have been good at that.

Q: I was thinking he developed a lot of programs, a lot of initiatives.

A: Oh, yes.

Q: I was thinking, he may have had somebody up there who was. ..

A: Well, of course, Bousquet went up there. And, let's see. .. There was somebody. I saw another name, Joe Brennan, on there that went up to the Congress from our office. They might have helped.

Q: Because a lot of his programs seemed to be interagency initiatives.

A: They involved a transfer of funds to other agencies, yes. The other agencies then, I don't know whether they also showed, I supposed they showed it in their budgets, too, and defended it in effect one way or another. I'm not sure just how that worked, as far as the other agencies were concerned. But the money was appropriated definitely for transfer. There wasn't any variation after the budget was prepared, why, the amount involved was specific. It was transferred.

Major Changes in the Cops of Engineers

Q: Okay. Let me ask you. In your time in the Corps of Engineers, in the '50s and '60s especially, what were the major changes in hydrology that in its use in the Corps?

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A: I don't think the model, the mathematical models, they certainly weren't prolific in the '50s. I suppose by the '60s, a lot of people like Ray Linsley, I mentioned, and some people in the Geological Survey, and Roy Beard out at the Hydrologic Engineering Center, they were all developing mathematical models to do the things we had been doing more by hand previous to that. I suppose that was a major change. Of course, the only way you could do that was to use computers. I guess that was just a normal development. Probably the same thing was happening in every other field also as the computers became more usable. I've forgotten when the Hydrologic Engineering Center was established.

Q: Early '60s, I think, wasn't it? '62, '63, '64, something like that.

A: I thought it was in the '60s. It was after we had the meeting with Von Neumann. That must have been back in the '50s. But the Hydrologic Engineering Center, that was around the low '60s or late '50s. They were in the forefront of that change that was going on.

Q: Now, in an area like hydrology, computers were very critical because of the large amounts of data you had to analyze?

A: Just like I think I mentioned when we were studying regulation procedures for Lake Ontario, to run it through 100 years of data, even though it was on a monthly basis, doing it by hand was a horrible job. Whereas the Canadians started developing computer programs for it where they could do it a lot faster than I could. It's just like when I was in Paris I decided I wasn't going to learn French. I never did get very deep into being able to program, to write programs for computers. I just never really had any opportunity, and I didn't have any burning desire or something like that.

Q: So you had somebody else do that for you, right?

A: Yes. Well, the people that were good at mathematics--a lot of problems, hydraulic problems maybe more so than hydrologic problems, such as the flow of water. The theory was available on the flow of water and the mathematics were available, but it was too complex to solve by hand. But as the computers became available and the people were able to solve these equations with the computers, why, then they did begin to become a little more scientific, use more scientific procedures in solving water problems. Gosh, today when I read these publications and stuff of the things

that they're writing the mathematics for and then solving with computers, it's out of this world.

Q: They can do an awful lot, can't they?

A: Yes, of course, sometimes it's not all that good. I mean sometimes the mathematics is not right. There's that saying, what you put into computers is what you get out. The main trouble is you don't know whether something has gone wrong internally. Take hydrologic problems such as forecasting. Unless you have some practical knowledge and are able to recognize when the computer is giving you a bad answer, you can really go haywire.

Q: We found that out with the Intel pentium chip.

A: Yes.

Q: Of course, those were calculations to the what, ninth decimal point?

A: That was in a limited area; but it was there nevertheless.

Q: How about other Federal agencies beyond the Corps? How did they mature in their use of hydrology?

A: I think everybody sort of came along together. The Weather Bureau started setting up river centers to replace the local offices who maybe had only one river basin. The river centers developed programs for flood forecasting. But I think I mentioned when there was a large flood, the center at Harrisburg, which includes the Potomac River and the Susquehanna River, got flooded out and lost their computer. All of the agencies had competent people. There were probably people from time-to-time that led the way, but I don't know of anyone that fell way behind.

The Soil Conservation Service was always active in all of these interagency activities. They still are. I still see peoples' names writing papers and stuff. They developed a procedure for estimating the amount of runoff from rainfall and had a family of curves and it has survived pretty well. I still see people referring to it in articles. Each department on the Interagency Committee had a representative on the subcommittees. We received permission for the TVA to be on the subcommittees.

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Departments like Agriculture had one official member of the subcommittee that usually was rotated among the SCS, Agricultural Research Service, and the Forest Service. Representatives of all agencies could participate in the meetings. Also representatives of other interested agencies could participate. We had someone from the Weather Bureau. Were they in Agriculture then?

Q: Commerce, weren't they?

A: Yes, Commerce. Commerce was a member of the main family. But anyhow, the TVA had a representative on the subcommittees, and we would meet down at Knoxville, occasionally. I'd spent a couple of years or a year and a half at Knoxville.

Q: Like you said, the TVA was always very busy with the flood forecasting business because of all of the dams they had.

A: Yes, yes. Well, anybody that operates dams has to worry about that. They have large tributary dams like Norris. Norris was the first one of the large storage projects. All of the main stem dams don't have any storage to speak of, so they have their gate operations. They have to open up their gates as the flow increases so that they don't cause any troubles. So they were in the business fairly early.

Q: How about non-Federal institutes, such as universities and these private research labs and private firms?

A: As far as what?

Q: Their contributions to hydrology. I imagine the universities have a lot of theoretical development.

A: Well, the universities became more active after the state water resource centers were established. The universities, I believe in the early '60s, organized a "Universal Council on Water Resources Research." They are still quite active. In the earlier days, of course, at the professional organizational meetings, there were always university people giving papers and participating. Not necessarily real early in the game, but some of the universities began being interested in having hydrology, teaching hydrology. That started rather slow, I think. I don't remember which

universities led the way, but there were a number of universities started developing hydrologic programs in their courses. I don't really remember which ones led the way.

The AGU was always heavily weighted with university people. I'd say the majority of the members were, maybe still are, university people. Hydrology was alive, even back in 1934 when Robert E. Horton was on the scene in AGU. I'm not sure where it was on the organization chart. Now it's a section just like everything else. Sort of equal among ten or twelve different units. I joined the AGU in '35, and started going to the meetings since I was in Washington on that USGS study. The attendees were mostly university people. But as I mentioned before, one of the men that was active in the hydrology was the chief engineer of the Pennsylvania Water and Power Company that had a couple of dams that they operated and was interested in hydrology.

There were some private companies that had, I suppose they'd be consulting engineers, hydrologists on their staff. They would have probably been in the AGU early in the game. Later on, the big engineering company on the West Coast. ..

Q: Bechtel?

A: Bechtel, yes, they've for years had several fellows that I know out there as head of their hydrology. They get involved in building dams and stuff like that where they have to prepare spillway designs. I suppose a lot of projects require discharge computations of one kind or another. One man there for awhile was from the TVA. I have known the last three men that were out there in charge of their hydrology divisions. I'm sure there are others.

Any large consulting company that did work in water resources would have gradually had to have a hydrologist, or someone capable in that field. They had hydraulic people, too. It may be that in the beginning like every place else, hydraulic people did their hydrology for them.

Q: Then the demand built up so that it went back to the universities to develop hydrology as a field of study. A more legitimate field of study because of the demand for the use of their services.

A: Yes, yes.

Q: Well, that's about enough for tonight, I think. We've gone pretty far, and I do want to come back again. I have some things I need to return to you anyway.

BG William Whipple Jr.

Q: I want to start by asking you if there is anything else that you wanted to talk about of the many things we've talked about? Was there anything that you can think of that you wanted to talk anymore about from your Corps days?

A: I'm not really sure about everything that we covered. But something came to mind. You remember Colonel Whipple, who was pushing the computers. I don't know whether he's gotten credit or blame for it, but he was one of the first people that started a new view of stream pollution.

After he left the Corps and was up in New Jersey, he pointed out and illustrated that much of the pollution in the streams was not from the sanitary sewers and treatment plants, but it was from the non-point street runoff and non-sewered areas. He established some gauging stations to prove his point. Congress has passed legislation. All of the cities have to develop plans for controlling that pollution, too. It's almost an unsolvable problem.

But, he's the one. I don't know whether he was actually the first, but he was one that really brought that problem out in the open. Everybody was concerned about sewage treatment and everything. He discussed at meetings that the pollution, there was more of it maybe coming from the non-point sources than there was from the sanitary systems.

Q: How much did you get into that?

A: I never did get into that, no.

Q: Other pollution issues. Of course, that was before, you retired before that really came in.

A: Oh, yes. I retired a long time before that.

Q: NEPA.

A: Yes, I think he was at the university when he was doing that research.

Q: Princeton? Was it Princeton?

A: Yes. I don't know whether he's gotten credit for that or not, but he certainly started the ball rolling.

Q: Well, he must have done that when he was with the State of New Jersey in what, water resources or Department of Water Resources, or something he was in?

A: Oh, the Congress set up a program where all of the states established, I think they called it Water Resource Centers, didn't they?

Q: Yes, there was something like that.

A: Yes. Almost every state established one. The Geological Survey budgeted the money for them. Now they're cutting back on that. I think he probably was teaching, too, but I think he was in charge of New Jersey's Water Resource Research Center.

Q: Well, he worked for the State of New Jersey.

A: Yes.

Q: May even have been the Department of Natural Resources or something. I can't quite remember. Now, getting back to your suggestion, I don't know that, as I say, I'm not really clear on what everything, or I don't remember exactly everything we've talked about anyhow, so I don't really. ..

Consulting Engineer

Q: Well, one of the things we didn't talk about was your time as a consulting engineer. That was quite a significant amount of time from 1966, or starting in 1967, but you had done consulting before that.

A: I had done it five, I don't know, five, ten years before. I would take leave. Gail Hathaway got me into a lot of that work in the beginning while he was with the World Bank and then later on, Wendell Johnson, after he retired and was doing consulting work, why, he also got me into a lot of projects.

But most of it was in connection with the spillway, the hydrologic spillway design of large dams all over the world. I think I must have worked on six or seven down in Columbia out of Bogota for Carlos Ospina. He had an engineering company of his own, Ingitec, a pretty big company. I guess, probably, my contact with him was probably through Hathaway. I'm not sure. They retained me a number of times to either develop or review their spillway designs. Mostly it was to develop them and that's when I formed a partnership with Dwight Nunn. I don't know whether you've run into his name or not.

Q: No.

A: He was in our office, in the Chief's Office, and then he transferred to the Nuclear Regulatory Commission, and he was a principal hydrologist there. When we formed our partnership, he had retired from the Nuclear Regulatory Commission. We got a lot of work from the Nuclear Regulatory Commission, too. I had been working in South America before he retired from NRC, but he had meteorological training during World War II. After the war was over, he was in the Chief's Office. So he did the meteorological, he developed the probable maximum storms and then I would develop the floods. They would use these for the spillway design studies then.

Q: Were there any unusual conditions you had to consider in those South American dams?

A: What about them?

Q: Any unusual conditions, hydrographic conditions?

A: No, except most of them were in pretty rugged country. Carlos Ospina, who's still active, I guess he's an associate member, I see him at the meetings of the National Academy of Engineering. He totally subscribed to the idea of using these maximum conditions for the spillway design to be sure that the dams would be safe. A lot of people didn't do that, but he was one that did.

It's an interesting thing. One of his structural consultants was Barry Cooke. A couple of months ago I got a phone call from him in San Francisco. Dam building has sort of quieted down in Colombia like it did here. But apparently, they were going to work on another project, and, at Ospina's request, Barry called me up and wanted to know whether I was available. I told him I just wouldn't be able to do it. I had retired and I wouldn't be able to do a good job for them. But I thought that was real interesting after, I guess it's been ten years or more since, even probably more than that since I'd done anything for Ospina.

Q: That's a nice compliment, though.

A: Yes, yes. It made me feel good.

Q: Was there anything about the designs of any of those dams that was different from the way the Corps would do it, the Bureau of Reclamation?

A: No, I don't think so. A lot of them were concrete, and Ospina was right up on the top of things. He was active in the International Commission on Large Dams, an international organization of dam builders that meets periodically. I guess that's probably where he met, where he got acquainted with Hathaway and Wendell Johnson. But I don't know of anything--there may have been structural problems, but I don't recall getting involved in them. He was a great believer in doing everything right. It was real nice work because quite often we'd go out and visit the dam sites and see some real rugged country.

Bogota is right at the foothill of the Andes. We had to go up over those to get back up into the country. There were areas even then where it wasn't safe to go in Colombia because there were always some rebels. I don't know whether they were in the drug business then or something else. But there were places that you couldn't go safely in Colombia thirty years ago.

Q: I guess that's occurring more frequently now again, too. Beyond the drug situation, it's also political.

A: Oh, yes.

Q: I think leftists guerrillas. . .

A: It's gotten terrible.

Q: **Did** you work in any other South American countries?

A: No. I did a job in Mexico. I reviewed a job in Mexico once, but I didn't even go down to Mexico. I think it was mostly reviewing a design and someone else had done on a dam in Mexico. The different projects are listed in the resume I gave you.

One of these, one job in South America in Colombia there, we went out by jeep to a camp they had, and then from then on, we went on horseback. They wanted to know whether I was a rider. Well, I had ridden horses, but not very much. We went on horseback from the camp to the dam site. During the night, someone took off with some of the horses. I don't know whether they stole them or just what happened. So when we went to the dam site, some of the local help didn't have horses.

I remember when we came back from the dam site, I guess he was one of the natives there that was taking care of the horses, he hung onto the tail of my horse and the other people were sort of ahead of us. They didn't slow down a bit so we were going fairly fast. That chap hung onto the tail of that horse, and he was really flying through the air to get back to the camp.

One of the nice jobs, it was one of the first ones I got after I retired, I was at an International Union of Geodesy and Geophysics meeting in Helsinki. I got a note there asking if I would stop in London on the way home, which I did. My wife was with me. She came on home, and I got off in London. This was for a British firm that had the World Bank contract on the Roseires Dam out on the Blue Nile in the Sudan. It's been built, too. They raise a lot of cotton there and they need lots of water--this was on the Blue Nile just shortly after it comes out of Ethiopia. They set up an international panel on flood discharges consisting of A. Bleasdale, a

meteorologist, Thomas Thompson, a geologist, and myself. We spent about three weeks in the field. So we had quite a trip there and they really took care of us.

We spent a week in Ethiopia, because that's where most of the water came from out of Ethiopia into the Sudan. The Italians had taken over Ethiopia for a 'number of years. They established a lot of rainfall stations and not so many stream gauging stations, but a lot of rainfall stations. So there was a lot of rainfall data available. Some of it was published, too, and we collected some other data, too.

We had an appointment to see the Emperor Haile Selassie. Then the party broke up and some of us went one place, and some went another, and so they canceled the meeting. But previously, I guess it was in Helsinki, that my wife and I had met a Jesuit who was from, what's the capital of Ethiopia?

Q: Addis Ababa?

A: Yes. This Jesuit was in Addis Ababa and apparently he was Haile Selassie's right-hand man on weather forecasting, so I looked him up when we were in Addis Ababa and we had him in for dinner. He told us, I forgot what the story was, some interesting story about how he had gotten Haile Selassie's attention and became his favorite weather forecaster.

Thompson, a geologist, was looking at field indications of past flood levels to get an idea of the historic, or non-historic events that might have happened. He was scheduled to go on a helicopter trip. The day before he was to go, the helicopter was out on some other job and it crashed and killed one of the pilots and one of the passengers. So he figured maybe he was lucky he just missed it by one day.

I don't like helicopters, although I flew from Athens all of the way, I suppose it must have been 200 miles up to the northern part of Greece to see a dam site in a military helicopter. There wasn't any landing place for a regular plane and because of time schedules, they took me up in a helicopter. But that's diverting. But anyhow, we had quite a nice stay in, I'm trying to think of the capital of Sudan.

Q: That's Khartoum, isn't it?

A: Khartoum, yes. We stayed at an old English hotel which had a view out over the Nile River. Some places we'd only use bottled water, and other places we could use the regular water. But I guess we were using bottled water in Khartoum. We were

sitting at the bar one night and there was sort of a dividing wall, between the bar and the dining room. The waiters would come to the opening there at the wall to get drinks and stuff for the dining room. Several times the waiter took the cap off the bottled water and then rubbed his hand across the top of the bottle, so I figured they weren't gaining very much by having bottled water.

Q: Cleaning it off, huh? How good was the historical data that they had on the rainfall in a country like Ethiopia?

A: On the rainfall itself? I forgot when the Italians took over.

Q: '35.

A: '35. There were some records predating that. But they were just the routine records. I don't remember any extraordinary events that had been recorded. Thompson developed some estimates of historical flood discharges based on his field investigations. Bleasdale prepared the estimates of probable maximum rainfall and I computed a spillway design flood. Our results were presented in a joint report.

We went on a safari up to the dam site. We flew to the nearest airfield, and then we were met by our safari group, and boy, I'll tell you it was something. There were two or three of the Sudan officials with us plus the three consultants. We must have had thirty or so in the crew, waiters and helpers, and boy, I tell you, it was really a first-class safari. We were out in the wilderness, but we had linen and silverware, and everything.

The first thing we did when we got up near the dam site was to go and visit the local tribal chief. It was the thing to do, I guess. We had an audience with him at his village there. He had a chair. He had someone with operating a fan and everything over him. This guy was quite interesting, too. We were camping on the banks of the Blue Nile. We saw a lot of native animals around. It wasn't safe to go swimming. I guess it was rhinoceros or hippopotamus, but there were some of them around.

Q: Something there.

A: One evening, we could see a big fire. One of the native villages burned up across the other side of the river. In that country with a lot of rainfall and everything, the

grass grows real high. At the villages they clear an area around so that if they have a fire, it won't get into their huts. But there was always some funny story about this fire. You got the impression they felt that someone had started it. It wasn't an accident. I don't know that anybody got hurt. But you could really see the smoke and flames. But that safari was quite a deal.

Lake Barcroft Dam

In addition to these large dam jobs from time-to-time, I'd work on some local problems for somebody. I guess it must have been spread out over 10-15 years, I was involved in the problems of the Lake Barcroft Dam. I don't know whether you're familiar with that or not. There must have been during that period of time, four real large storms that hit that area. The first couple of jobs involved lawsuits by people downstream. Holmes Run goes on down through Alexandria past the big Army installation.

Q: Cameron Station?

A: Cameron Station. This creek runs right on the edge of Cameron Station before it becomes Cameron Run. They've rebuilt that whole area. I haven't been down to see it, but there was a railroad trestle there that blocked the flow of the creek. When there was a big storm, why, the water would backup and almost overflow, sometimes it did overflow the railroad tracks. It would back up a side channel in upstream of the railroad tracks, and there was development in there. Those people sued Lake Barcroft saying they had caused their damage.

The dam at that time had wooden gates that were hinged at the third point so that they would tip just when the water overflowed. People would sue and say that they opened up the gates improperly and flooded them downstream. The work was for the law firm of Boothe, Dudley, Koontz--the man I worked for was Armistead Boothe. The law firm, started by his father, who had been a high state official.

Armistead is one of the few lawyers that I respected. Armistead, he was one, and I've known one other that I admire. But he was the defending attorney on this Lake Barcroft stuff. He always wanted to know the truth. He didn't want any bias one way or the other. He wanted to know what happened, then he would decide whether he would use me or not. But he never wanted you to fudge your figures to favor his lawsuit. He wanted to know what, to the best of your ability, what the situation

was. I don't think that's true of a lot of lawyers. But we won. I think we won the first lawsuit.

Then the second lawsuit, there was another flood later on. They claimed that the dam tender opened the gates all opened at once. The gates were set so that the tilting elevation was at several different levels. They were wood gates with hinges and with seals on the edges of the gates to make them watertight. The friction on those gates, it would be different on every gate.

The way they were supposed to work, when the water got to a certain level, a gate would tip and then the water would drop. When it worked up again, when it got to a certain level, supposedly another gate would tip. But the people suing, their attorney claimed that the dam tender had tipped them, or they had all tipped at once, which sent a flood wave down stream.

Ordinarily, witnesses aren't allowed in, during the proceedings. But Armistead always got the permission of the judge to let me sit with him in the courtroom. When they were picking the jury, one of the prospects was an engineer. I don't remember what kind of an engineer he was, but they thought that would be good to have an engineer on the jury. So he was on the jury. We lost the case.

Armistead knew everybody in Alexandria. If he'd go down the street, he knew everybody and he was an outgoing person that was friendly and polite to everybody. He found out from the bailiff, that this engineer had insisted that if those gates were designed to tip a certain way, they would absolutely tip that way. There'd be no friction or anything. It wouldn't make any difference on these gates. So he argued that they would all tip at once. I guess that was the reason we lost the case.

Then, at that time, the Alexandria water supply was owned by a private company out of Philadelphia. The dam there on the Occoquan, they raised the dam and made a much bigger reservoir, and so they had to go around and settle all the land titles. There were a lot of lawsuits in connection with their taking of the land. I was in on some of those cases with Armistead Booth.

The Corps has very rigid rules. They only take what they need. But the water company would buy a whole piece of land. They had a lot of land around that reservoir they didn't need. Armistead and I kept talking about buying some of that surplus land, but he was too busy to do anything about it. Then it got to the point where, I guess they figured it wouldn't look right if the water company sold their attorney a piece of land like that. But that land is being used now, all around that reservoir.

Q: I imagine it's pretty expensive, too.

A: Yes, I imagine so. We looked at several, 200-300 acre pieces that the water company had bought. It was easier for them, I guess, to buy the whole property than it was to buy a piece of it.

Another cast was Four-Mile Run, which starts in east Falls Church. Its drainage is from Arlington and Fairfax Counties and Alexandria. It runs down along the edge of Alexandria. It's almost all Hispanic now I think. It's as you go into Alexandria from Arlington and that area got flooded badly a number of times. The Corps finally did a big project on it.

But there part of the problem, too, was that it goes underneath all of the railroad tracks there into the Potomac right adjacent to the airport. The water would back up from those openings underneath the railroad tracks and it would flood that section of Alexandria. So a number of the citizens, the property owners there, hired Boothe to sue the city because of, I guess primarily of negligence. The case was heard in court and we won the jury decision. The dam judge reversed it.

Armistead still had a little money left over so he appealed it to the Supreme Court. But they backed up the judge. I saw that Supreme Court ruling, and I never saw anything so stupid as the justification they used for supporting the judge overriding the jury. From then on, I've always wondered about the Virginia Supreme Court, just what they were, and what good they were.

Q: All political appointees, right? What was your most challenging consulting job?

A: I think the most, maybe I could think of others as challenging, but the most interesting was Lake Barcroft. Finally the dam abutment washed out. There were a lot of lawsuits about that. I had, a friend that was a state senator and had been the majority leader. He is still living, but retired. He's a lawyer, and has a law firm.

On that dam washout problem, Armistead Booth was not involved. This other law firm was part of the defense. So this acquaintance of mine, who was a partner in the law firm retained me as a consultant on that dam failure. It was, I don't remember the year, but it was that storm where they had 15-16 inches of rain out around in that area there. Whether it was '71. ..

Q: Was that when Agnes, Hurricane Agnes. .? That was '72.

A: So I had to do a lot of flood routing and what not to make various estimates of what would happen downstream. The way the dam was operated, it didn't really seem to have added much to the flooding downstream because most of the flooding was due to the backup, these railroad trestles that backed up into that same area again. They also hired some other engineers who were more into the computer- business. I did my stuff by hand and they did a lot of flood routing on their computers. They settled before it went to trial.

They paid the plaintiff's legal costs, so the case never went to trial. But that Lake Barcroft thing, that was something. From the very beginning I had lived close by and when there was a heavy storm or something, I'd go out there, actually during that heavy storm I was out there. Then, right after, I was out there, got some flood marks and stuff and did a little surveying that later helped my computations because you needed to know how high the reservoir got. You needed to know the size of the washout section of the abutment to figure out what went out. I really enjoyed that.

The Most Complicated Job: Bangladesh, Pakistan, and India

Getting back to what was the most complicated. Probably at the time I thought a lot of them were, but I don't remember any as being usually so. I'll tell you what's running through my mind. In the later years, many of my jobs were in Pakistan through the World Bank. The World Bank requires anybody they loan their money to for a large dam, why they require them to retain a highly reputable engineering firm. Then the firms always set up consulting boards.

The work started first in what was then East Pakistan and now Bangladesh. At that time, when it was East Pakistan, there was a firm operating out of a big city in Pakistan. ..

Q: Karachi?

A: Yes, Karachi. That's where their headquarters were located. Their initials were ACE, Associated Consulting Engineers. When they set up these contracts, they generally have an international firm, which often work with a local firm of engineers. This ACE was the Pakistani company. The head of the firm was in Washington.

Q: I'm going to stop you for just a minute.

A: So Mr. Azeemuddin called me, and I went down and talked to him down at his hotel. He was really a character, but we seemed to hit it off pretty good so he saw to it that I got on the board of consultants that would be handling the consulting part, act as the consultants for his company. His was the only firm involved. There may not have been an international company at that time. He was sort of international. I think his company handled the whole business. They were studying a possible dam site on the famous river that just recently they had floods there again.

Q: The Ganges?

A: Ganges, yes. And the capital there of. . .

Q: India is right on it, I think. New Delhi?

A: No, it's Dacca then, Dhaka now. When the river got high, the whole city would be surrounded with water. A later project that I was on was studying the idea of building a levee around the city with a lot of pumps to pump in and pump out. I don't think that ever got off the ground. But anyhow, at this time, they were studying the possibility of a dam on the Ganges just below the Indian border. So I had several, two or three, trips to East Pakistan at that time working for ACE and the World Bank. One time we were there, it was the time when they had a major disaster.

Dhaka is quite a fair-sized city, and there was one of the international hotels there that we stayed in. We flew up to near the dam site. While we were out, they had the typhoon on the Bay of Bengal. That was the one that drowned some 500,000 people. It was the worst one they have had in recent years. So we got word that if we wanted to land at the airport should we get back. So we went back before we planned and landed at the Dacca Airport.

In the newspaper, I saw an Associated Press item that said that a World Bank consulting team was lost in the southern area in this typhoon. That they had been down there and were unreported. As soon as I saw that in the paper, I knew my wife would see it here, so I sent a telegram. She heard about it a day or so before she got the damn telegram and it did worry her. She called up Wendell Johnson and

he called Ralph Blour, the man that headed the structural engineering that went over to the World Bank. I mentioned him once before, and I couldn't think of his name. He followed Hathaway over there.

So Wendell Johnson called Ralph Blour. This was on a Sunday, I think. They called the World Bank and as far as they could find out, everyone was okay. I think they got my wife calmed down. Then about that time, she got my telegram. But, of course, what the paper didn't say was that there were three or four different World Bank teams there. There was a bank team down in the area. They were down there checking, working out a project to build better levee protection. In the meantime, they had built some concrete structures. These people were in a boat, but they had gotten to this concrete structure and they were all safe. But that really must have been horrible. It was over 500,000 people drowned.

Q: They've had a couple more of those since then, haven't they? they've had a couple more of those typhoons.

A: Yes, they have, but I don't think any of the recent ones have been near as bad as that one. I don't know whether they've ever done much--there really is not too much they can do about it. Apparently, it's not practical to build the levees high enough to protect them. They have protection for smaller storms, but not for the larger storms.

But while we were there in Dacca, the relief supplies started coming in. They were piled all over the airport, but they just didn't have any organization or facilities to get the stuff down to where the people needed it. It was just stacked up in the airport. I guess, eventually, they did work something out.

The gentleman's name that was the head of ACE was Azeemuddin. He has died. His son is now the head of the company. I still get seasons greeting cards from him. They have offices in other countries where they do a lot of work other than just in Pakistan. But Azeemuddin had a good sense of humor. He smoked. He'd buy a package of some cheap, I guess they were cheap cigars. It wasn't because he couldn't afford something better, but he would have these cigars, and I'd smoke some with him and that always made him happy.

Bangladesh grows a lot of, it's a regular plant, but it could be made into a drug. The natives chew the leaves--I don't know what they do to it to make a drug out of it. But, well, they make hemp, too. I guess that's what they call it, hemp.

Q: Yes, I guess there is something like that.

A: Yes. But he would chew this stuff. His teeth were really discolored. That was just a natural habit that the people had, chewing that stuff. Certainly didn't do anything for his teeth. But he was, he always did right by me.

Q: Which is all that matters in the long run.

A: Yes, yes. As I say, he had a sense of humor. Somehow or other we struck it off pretty good. But after Pakistan split off, East Pakistan became independent as Bangladesh, why, then we started doing some jobs in Pakistan itself. We worked on a dam site down below Tarbella, the big dam. They were finishing Tarbella, but there was still one possible additional dam site downstream that they were trying to get the World Bank to finance. It was a real difficult site for the structural engineers.

I remember one time, my wife was with me there, too, and we were not operating out of Karachi, but we were operating out of the city of, in the upper country. ..

Q: Lahore?

A: Lahore, yes. One of the consultants was Ed Fucik from Chicago, the Harza Engineering Company in Chicago. He was one of the U.S. members of the board. His wife was in Lahore, too. The Board went on a trip up to the dam site, and Mrs. Snyder got fairly well acquainted with Mrs. Fucik. I think his wife was a Harza and that he was a major owner of the company. A side light--Mrs. Fucik wondered why my wife put a pair of my shoes outside of the hotel room door each night to be polished. Her answer was that people would not know that I was away.

Anyhow, we went on a field trip. They took us by train and pullman cars up as far as they could go and then we went by jeep to the dam site. You wondered how they could find the dam site there. They were working on one, and I think they're still working on it. I don't know whether they got financing, whether they ever started it or not.

But Tarbela, the big dam upstream, you probably don't remember. They had a blowout. The dam was a tremendous large dam. The reservoir was nearly full and a tunnel blew out the whole upper face of the dam. It was an earthen or rock fill

dam. They really were scared. I wasn't involved in that dam, but some of the people I worked with were. Wendell Johnson, I think, was. But they called all of the consultants in from all over the world, wherever they were there because it was nip and tuck just what they had to do to keep that dam. If that dam had washed out, it would have really taken the whole countryside with it. It's a tremendous dam. I think it's 400 feet high. For an earth dam, that's high. I don't know how many thousand feet wide it is. But it's a tremendous dam.

Later on Harza had a consulting contract with Pakistan to study general flood problems. They sent me over there for a month or two. I was never quite sure why they wanted me, but I got interested in some things so I wrote a report on them for them.

But while I was there I decided, and they approved it, so I flew up to Islamabad, which was just getting started then. They had started building their buildings and everything. There was an airport there. That was the nearest airport to Tarbella. They took me out to the dam, and the engineer there took me on a tour down through this tunnel that had blown out and everything. I saw the work they were doing to rebuild it. So that was a little plus. I got to see that dam.

Q: What would have caused that to happen, that kind of thing?

A: I'm sure I knew once or I knew what they thought had happened. I think somebody failed to do something that they should have done in operating some gates. It shouldn't have happened ordinarily anyhow. I mean you have gates on a tunnel, you should be able to use them.

Q: The whole dam, yes.

A: An unusual pressure upstream. So it was not only what happened on the tunnels, but there must have been some weakness in the material on the upstream face. It blew an awful hole in the upstream face of that dam.

Q: Jake Douma did some consulting on some of this.

A: Oh, yes. Later on when they, as they were rebuilding it, they did a number of things, and Jake made a lot of trips over there. I don't know that he was in

originally, but when the rebuilding and the redoing it went on, he was over there a number of times.

Q: Well, he told me in the interview that the quality of the construction wasn't very good in some of those dams. That the tolerances were very bad.

A: The what?

Q: You know, the quality of the construction. He had a problem in one of the dams where the joints just didn't fit right in this concrete spillway. He said it led to a lot of erosion down there, and he said the quality just wasn't good enough.

A: Well, I'm sure whether it was an earth or a rock dam, I'm sure there was a concrete spillway. The spillway was over on the other side of the dam, as I remember. They had trouble with the stilling basin and everything there and I'm sure that's what Jake was involved in. They worked on that, I think some little time even after they had taken care of the damaged part. They were working on the spillway and the outlets over on the other side of the dam for some time.

Q: Yes, because he was working with Harza on that.

A: Yes, Harza or TAMS.

Q: They had him on that one. Are there any other things in Pakistan or that area that you got involved with?

A: When we were in Bangladesh, the beggars were everywhere, and this was years ago. That country's a disaster. I mean there's just no way they're ever going to be able to support themselves. Britain and several of the big countries know this, and so they have a consortium that sort of looks after them on projects and things like that. When -we'd leave the hotel in the morning, the streets would be lined with beggars. There'd be women there holding babies. They told us that they rented the babies just to help out with their begging. It was not a happy situation.

Mary was with me several times in East Pakistan, or at least once. The engineering company had a local office there, and the manager's wife took Mary on a shopping tour and she said that was something, too. They had a chauffeur. I'm trying to

think something about, I think they saw an accident where somebody had bumped into a bicycle rider. Something interesting about it though. Apparently, the bicycle rider, he was the number one. The guy in the car was in trouble, the one that hit him. I guess that may be true in some other places, too, where bicycles are predominant.

Q: I imagine there are a lot of them in those countries because of the lack of money. So mostly rich people and foreigners have cars.

A: I wanted to get something for Mary one time I was there, so Azeemuddin took me shopping, and he knew the ins and outs of shopping. I ended up buying some pink pearls. They're just found in certain places, I guess. I liked those. They have faded. I don't think they were fakes or anything, but apparently they fade. Mary never used them very much. I think they're still in her drawer in there. The last time I saw them they were not very pink anymore. But anyhow, he took me to a place, and got me a special price on those.

Everytime I'd go over there I'd buy a rug. Both Pakistanis and Indians are famous for making rugs. The Pakistanis make a lot of rugs. I got a half a dozen around here and I've given some of them away. I went where they use child labor to watch them working on them. They're probably not the same quality as the so-called Persian rugs. But they're pretty nice. Interestingly, after they get them made, they scrub them. They wash them and scrub them down with water. You wouldn't ordinarily think of doing that. But I guess that gets rid of something that's on them when they're making them.

Q: Those things are so expensive now. Even the Pakistani ones probably are pretty expensive.

A: I suppose so. Well, there's one downstairs when you come in. There's one, you see it in the spare bedroom there, too, lying on the floor in there. I've given a couple to the children. I think I paid about one hundred dollars for them. Of course, I always had somebody that was giving me support when I bought them.

Q: Somebody who knew the dealer.

A: Yes.

Q: Can get you a good price. Figure out how to get it back to the States.

A: I may have brought one back or so, but generally they would ship them for you. You'd pay them for the shipping. That tall clock just around the corner there, it cost just as much to ship it from London as it did to buy the clock. It came into Baltimore. We had to go over to Baltimore to get it. The works, it's an antique, so there's no duty on it, but the darn guy was an eager-beaver and he wasn't sure that the works were old or not. He thought they might be new. So I think we had to, he was closing up shop or something, so we had to come home and then go back to Baltimore again to get that guy straightened out, being an antique. I'll show it to you. That cane over there came from London.

Q: The middle one?

A: The one standing up straight.

Q: Oh, this one.

A: That was made for a Saudi. prince. He never picked it up. That was the story I got. So I'll show you what's interesting about it. It's got a blade in it.

Q: For protection purposes?

A: The trouble is you can't take it, I can't take the darn thing on an airplane or anything. It would never go.

Q: Through the X-ray, would it?

A: Never go through the security.

Q: Maybe that's what he decided. Those guys fly Saudia, so they can do anything they want.

A: Yes.

Q: Did you do any consulting in Canada? I think you did up there, too, didn't you?

A: Yes, yes. They were getting ready to build a dam on the Columbia before it comes out of Canada. The hydrologist in the North Pacific Division, who had gotten in on this computer business early in the game, developed their probable maximum flood. In that situation, there's a lot of snow. It's mostly snow, melting snow, and some rain.

So the engineering company in Vancouver, I don't know why, but they wanted it reviewed. So I reviewed the spillway design flood for them. On one of the trips out there, took the family along. We rented a car and drove on up to Banff and stayed at the famous railroad hotel there on the lake.

Q: Lake Louise?

A: Yes, yes. I don't know just when this was, but it was sometime in the summer and we had a little snowstorm. The kids got a lot of fun out of that.

Q: Yes, Lake Louise Hotel isn't quite what it used to be.

A: **Yes.**

Q: At least it wasn't about 13 years ago when I was up there.

A: You say it wasn't?

Q: No, it wasn't. It really wasn't in too good shape.

A: Is that right?

Q: But the Banff Springs Hotel in Banff, itself, was just beautiful.

A: Newer?

Q: I don't know if it's any newer, but it certainly was taken care of, yes. It was a Canadian-Pacific property. I think so is the other one. Well, there are two big railroads, Canadian-National and Canadian-Pacific. Each of them, I think, had their own hotels. But I think Banff Springs was a Canadian-Pacific hotel. It was still quite plush. I haven't seen it, of course, recently.

A: Later on, I did a job for Hydro Quebec. Wendell Johnson and Barry Cooke were on the board of consultants for this project in Eastern Canada. It was the Quebec Hydroelectric Company that was planning this. They had a half a dozen dams laid out for this stream that drains into James Bay. They were working on just one or two at the time.

Wendell was instrumental in having them set up a hydrology work group and he recommended me as one member. Barry Cooke was there at the time. Wendell got a kick out of it. He says when he suggested me, Barry Cooke said, "Oh, yes. We use him in South America, too." That was typical of Cooke. He was opinionated, but okay.

Q: Who did he work for? Did he work for Bechtel?

A: Cooke?

Q: Yes.

A: I don't know. I think in the beginning he worked for some of the power companies out there on the West Coast. I've seen articles about him in some of the magazines. He's been an independent consultant for many, many years. One time, when Mary and I were in San Francisco, he took us out to lunch. When he called me a month ago, I mentioned that to him. I think it made him happy that I had remembered that.

They had a lot of problems with the Indians, the natives up there, who lived on some of these streams, that they wanted to build dams on. But they finally got everything worked out. I don't know that they built all of the dams, but they built several of them on the stream. Hydro Quebec produces a tremendous amount of power. They sell a lot of it to New York State. They export a lot of it.

Q: Most of that is on the streams that drains into Hudson Bay, isn't it?

A: Yes, these streams drained into James Bay at the southern end of Hudson Bay.

Q: They're draining north into the Hudsons Bay, or west from Quebec.

A: Well, I think it went pretty much west.

Q: West?

A: Yes, into the bay. I don't know that the Hydro Quebec engineers that were on this working group, I don't think they were entirely too, happy having me involved. I suspect that they had done their own designing. I just have kind of forgotten the details. I imagine the Hydro Quebec engineers had designed the project and everything.

I had a little trouble getting all the information I wanted and everything. I didn't find anything wrong with what they had, but I never was really happy with the final approval that was made. It was just, the operation was too big. It was rather difficult to get your teeth into the details of what they came up with. But I wasn't unhappy with the results and with their design, but I wasn't 100 percent happy about it either. We just worked on the first dam. I never heard anything more from them on the other dams. I don't know whether Wendell was a consultant on some of the other dams or not, but they built some. I also worked on a project in Saskatchewan for Acres, International. I don't remember much about it. It's hard to retrieve the information because I gave all my files to the University of Wyoming.

Q: Now, on these World Bank projects, you gave a formal report to the World Bank or to the engineering group you worked for, or both?

A: Well, like the ones in Pakistan, our reports would go to those engineers, but of course, I'm sure they then would, if that was part of their procedure, they would be furnished to the Bank. But then I was on some jobs where I was hired by the Bank, itself. Then we made our report to the Bank. Quite a bit later, the Bank sent a team to Bangladesh on the protection of Dhaka.

It was in the paper in the last year, well maybe within the last six months, they were flooded out again. The Ganges comes down from the northwest, but then there's a major stream, the Brahmaputra, that comes in from the East.

Q: Right.

A: And it's an awful situation. When we were there, a Japanese firm had the contract, I think, the main contract. We were reviewing the plans they had prepared for providing protection around the whole city. I don't think everybody was convinced it was necessarily a feasible thing, but they had the plans for it. I don't know whether it was a matter of approval or not, or more just that the World Bank wanted more information about what was going on, but there was no objection to it that I remember.

But it would have been quite a project because the pumps would have had to be tremendous pumps to pump the rainfall out during the floods. But, also, some of them were to be reversible so that they could pump water in during the low water season. Those people live on these river banks. The whole country gets flooded, so when I say river banks, I guess it means that includes just about everything in certain sections. Their livelihood is dependent on the growing season in between the floods.

Q: That's a big delta, though, isn't it?

A: Yes.

Q: A big delta comes out there so that's why that's such a big problem? It's very low?

A: It's very flat. Yes, because as you go farther south, of course, you get into that area where it gets flooded by typhoons.

Q: The Bay of Bengal?

A: Yes.

Q: One of these two, I forget which one, but they just come right up the coast there, from Burma on up the coast, and just push the water up ahead of them.

A: Yes. Maybe the storms form in the Indian Ocean and can take several different paths.

Q: How did you find the work as a consultant versus the time you spent in the Corps of Engineers?

A: Everybody, including my wife, thought I was crazy when I retired when I did. I didn't have any assurance of how much consulting work I'd get. But I had a taste of it by what I had been doing before so I wasn't really concerned about it. I guess we would have survived whether I got any consulting work or not. Well, I was free of the paper work and the routine of working in an office.

I was pretty fortunate even in the office. I didn't get involved in much administrative stuff. I had my assigned duties, but I pretty much set my own schedule and everything. So I had a favorable position even when I was with the Corps. So I never had any great feeling of change, other than that I was a little freer, I guess, when I was a consultant. But I always enjoyed my work with the Corps so there was no feeling of relief or anything when I retired. I'd been perfectly happy with my work.

Q: How about the quality of the engineers that you dealt with in these various projects, compared to the people you dealt with in the Corps?

A: Well, with the Corps, my dealings were almost entirely with hydrology and hydraulics people. When I was on these consulting boards, although I was a kibitzer, I was in on the meeting of all of the structural, geologists, and everybody else. So there was a little difference in the associations. But I don't recall ever feeling that the Corps people were that I was dealing with were not doing an adequate job. I think they were all quite capable. Some were more talented than others, but the organization was such that the chain of command was such that there's almost always somebody in it that knew what he was doing.

Q: Well, you worked for a lot of top people, too, though.

A: Yes.

Q: You keep on mentioning Wendell Johnson and Gail Hathaway. Those are fairly big names in the business.

A: Yes, yes. You were talking more about, I assumed you were talking more about the bread and butter work. In other words, we reviewed all of the spillway designs for the various projects as they went along. So I got to know a lot of the field people in the hydrology and hydraulics branches.

Q: Now, you did have an advantage that you did deal with a wide spectrum of projects in the Corps of Engineers. A very wide spectrum of projects in the Corps.

A: You mean with the Corps?

Q: Right.

A: Yes, we got involved in the channel and levee designs on the local protection projects. But I was, at least in the later years, I was pretty much dealing primarily with the reservoirs.

Q: So these consulting jobs were sort of a significant change for you as far as kind of thing you did?

A: No.

Q: The same thing?

A: It was much of the same sort of thing, yes.

Q: Now, the environment though was different, more challenging environment, internationally.

A: Yes. And the travel and the people, of course, a lot of different people involved. But they always, it was amazing how nicely the consultants were always treated. I remember one time Mary and I flew into Bogota, and we got in there late at night. We had reservations at an international hotel. When we got there, they didn't have any rooms for us. Apparently, one of the airline companies that used the hotel had a big flight canceled? and they put all of the people back in the hotel for overnight. So I called up one of Ospina's people, and he came down the hotel and he took us someplace else and found us a place to stay. But the next day, they raised cane with

the hotel and we got back to the hotel. The first night we spent in a substitute. But they always took care of us pretty good.

Q: High-price talent?

A: Yes, yes.

Q: They had to treat you nicely.

A: Of course, I don't know whether I mentioned this before, on our trips to Pakistan, that's almost halfway around the world, I would get first-class tickets. Then sometimes I would change the first-class ticket into two regular seats and quite often would take Mary along without it costing me very much. Sometimes, though, I would have a first-class ticket, and she'd have a coach ticket and I'd let her use my first-class ticket and I would sit in coach.

But twice, we went around the world. The first time Slichter was on the board of consultants, and they decided to join us. Mary Slichter didn't want to go to Pakistan, so she met us in Hong Kong. But Mary, I, and Slich went to Pakistan and then went on around to, oh, we stopped in various places before we got to Hong Kong. Mary Slichter had an antique business for awhile. So she nearly bought out Hong Kong. We met her in Hong Kong and then on to Tokyo and Hawaii.

The other time, I guess it was later on, Mary and I went on around by ourselves and hit some other places on the way around. We went up to the snow mountain climbing country.

Q: Nepal?

A: Nepal, yes. We flew up to Nepal in a small plane from Dacca and spent several days in the capital city of Nepal. There again, there were a lot of beggars around. It was interesting though, apparently two of the religions used each others temples, I don't know whether it would be the Hindus and. ..

Q: Buddhist and the Dalai Llama, which is another. ..

A: Anyhow, I had the impression they used each others temples. That doesn't make much sense, and I don't know why, but anyhow, we visited some of the temples. Mary was Catholic, and I'm a Presbyterian. Whenever on a trip, she always insisted on going to Mass on Sundays. So we happened to be in Nepal on a Sunday, and we located a Catholic church and school. We took a taxi cab to the church, which was in a remote area, for Mass. I didn't pay him. I asked him to wait for us. When we came out of church, he was nowhere to be found. For a while we sort of felt stranded there, but someone that we had casually talked to must have seen us looking lost and took us back to the hotel. Several times, I went out and looked at the taxi line trying to find that guy, so I could pay him, but never did find him. So that was, I guess that was the most exciting thing that happened in Nepal. We bought a rug and some jewelry.

But when we came back, we flew back to Dacca to get on our flight starting out around the world. When we got there the airport was jammed. There was a big pilgrimage going to Mecca. All of the families, whoever was going, the rest of the family came down and the place was really crowded. We felt fortunate when we got out of there on our flight. I guess we headed for Thailand. We were on a Thai airline and went to Bangkok, Thailand. We spent several days there. Mary always complained that I traveled too much for the Corps. She was always saying I was traveling all of the time. So when we got the chance, she got all of the travel she wanted.

Q: Gave her something in return, huh?

A: Yes, yes.

Q: My wife complains about that, too.

A: Well, that's natural.

Q: I try to take her some places.

A: Yes.

Q: It's a little difficult during the school year because the kids are still young.

A: Oh, yes, yes. We were kind of fortunate. Some of the traveling was--before we had the third one, Mary's parents lived outside of Philadelphia, in Chester, so we parked the kids there occasionally. Mary had a cousin, a single cousin, who lived in this area, and one time she came over and stayed at the house with the children. She was a chief operator at the Pentagon. I don't know whether you've seen or not, but her assistant was Marian Bailey, who, of course, is the chief operator now, and became so when Mary's cousin retired. She is quite a well-known person around the Pentagon. She is the one that has a private scooter.

Q: Yes, yes.

A: She's a friend of ours. When Mary's cousin retired, she stayed here a little while, and then she went into a nursing home up in the Philadelphia area. Several times Bailey went with us to visit her. I talked to her when Mary passed away. She's way passed the retirement age.

Q: Yes, yes. She's got like 60 years or something. Some incredible number of years.

A: Yes.

Q: She still goes scooting around there. Yes, I saw her buggy out in the hallway here recently. The fringe and all her decals on it.

A: Yes.

Major Contributions to Hydrology

Q: Let me ask you, as we wrap this up. What do you think your major contributions were to hydrology?

A: Well, I think the papers I wrote. There isn't any question about that, the research I did and the papers that I wrote. I got the most mileage out of that synthetic unit graph paper, which was a case of being, I guess, at the right place at the right time. When Hathaway was, this was before he knew me, developing his programs in the Corps of using the probable maximum storms, this unit hydrograph fit right into it. So he was instrumental in most of the field offices using the procedures which helped establish my reputation. It did, for some reason or other, get all around the

world. It was used in a lot of different countries. I don't know exactly why, but it did spread around.

But actually, the best paper I wrote never really got much publicity or recognition. I think I had ideas then that people are still discovering as new.

Q: Which one was that?

A: "The Conception of Runoff Phenomena. "

Q: Oh, okay.

A: You know, in the old days, they would talk of runoff as a percent of rainfall, which would make you think that if you had an inch of rainfall, you were getting one tenth of an inch off of the whole basin, if you were getting 10 percent. That's not the way it happens. Then Horton had his infiltration theory, which is a great theory, but again, it isn't really the case. It's what happens if you take a square foot or a square yard, that's what happens. But on a basin-wide basis, it doesn't exactly work that way. A lot of procedures still use it, and it's still, I guess, accepted as a true phenomenon. But again, it isn't quite what happens on a natural river basin.

So in this conception of runoff phenomena, I hypothesized a basin with the areas lined up according to depth to the ground-water table. There are certain areas which have the shallowest depths and which become saturated first. My theory was that the soil, except for very exceptionally heavy rains, the soils have no limiting infiltration capacity. The soils will take the rain until they get saturated, and then you start getting surface runoff.

I mentioned the subsurface flow before, you're getting subsurface flow, too. The idea of sub-surface runoff was a significant development. However there were several other people working on it at the same time. I hypothesized, just as a model, the areas closest to the channels would saturate first and that's where your surface runoff would come from. So if you're getting 10 percent runoff, instead of 10 percent from the whole area, you're getting 100 percent from 10 percent of the area, and that area always produces the first runoff.

Well, that was in this conception of runoff phenomena. Some 15 or 20 years later, they started talking about partial-area-runoff, which is that same thing, that there are certain areas that always produce the initial runoff and that area expands as the

amount of rainfall increases. If it rains long enough, the whole basin contributes. But, I mean there's stuff like that in the paper that never did get much recognition.

Q: You think that was your best piece of work?

A: That's what I thought, yes.

Q: But your real reputation you think stands with the synthetic unit graph?

A: That really established me, I guess. As I say, it was translated into a lot of other languages and people when I'd go to these meetings, people would know who I was. I think I mentioned once before that they were surprised how young I was.

Q: That's a delightful story. It really is. Let me ask you. Now, that's in your career as a hydrologist. What about your time in the Corps of Engineers? Was it one of those manuals, the engineering manuals, you think? One of those things on reservoir regulation? What do you think was your major contribution in the Corps of Engineers itself?

A: Well, it would have been the reservoir operation procedure. In addition to the manual, a number of procedures for special operations were sent out in *Engineer Letters*. Some items went out as directives.

Q: Circulars?

A: Circulars or letters. I think we mentioned before if you have a certain amount of flood control space, and when you get a certain flood, there's always a question, "Should I use it all now or save some space for the next flood?" In other words, after you filled up, why you can make things worse, than if you hadn't built the darn because the reservoir area speeds the flood water through faster than it would have been in a state of nature. So you can make things worse.

So I developed a procedure that you could sort of take care of that situation of knowing how much space you should save. In most projects, there's some surcharge storage available before you have to pass the inflow. It was mostly how to use up this surcharge storage and still be prepared for a more severe event if it happened.

There was also a procedure for determining the amount of storage required to provide water supplies of different dependabilities.

I remember one time, I don't know whether I mentioned this before or not, I think it was in the Kansas City District, they had a bad flood. They went out and put sandbags on the spillway. I think they got called out pretty severely about doing that because dams aren't designed for that. You're not supposed to store more water than they were designed for. But by sandbagging a spillway, they were able to store some extra water.

Q: Although they weren't supposed to do that.

A: No, they certainly weren't supposed to do that. I think in that particular case, they didn't run into any second, into another storm, but they might have. It's not the thing to do. I think I mentioned before we issued the regulations for other agency dams that were funded -with flood control money, and private or local governments. There were a few dams built by states that were not federal dams, but that also got some money for flood control and we issued regulations for those. That was mostly a matter of just reviewing what the field offices had come up with, but it was still a little bit out of the routine, to be messing into someone else's business.

Q: Telling them how to do it, huh?

A: Yes.

Q: Is there anything else or any other observations you have on your career or the Corps of Engineers that you want to impart before we wrap this up?

A: No, it certainly was a satisfying career. I never hated to get up and go to the office. It was always anticipating something interesting. Hydrology was my hobby. When we lived in Arlington Village, I was running an experiment in the bathtub, timing the waves back and forth, checking out that V equaled the square root of gD . It checked out, too, but the neighbors got a kick out of that.

Q: Bathtub experimentation wave tank, huh'?

A: As I say, hydrology was my hobby as well as my vocation, which isn't necessarily a good thing, but it was enjoyable anyhow.

Q: So it worked out pretty well in your case?

A: Yes.

Q: It's nice to have it that way, makes it a lot easier on you.

A: Yes. It would be terrible to be unhappy with what you're doing and I have a feeling that an awful lot of people these days are in that situation. I don't know.

Q: Well, I think that's probably true.

A: Yes. I'm on a sucker list for all people trying to sell me these financial advisory letters. I do some speculating to keep myself interested. This one I was recently looking at, it demonstrated that taking into account inflation, that the average income now is less now than it was years ago.

Q: Yes, the usable income.

A: Yes. The division between the haves and the have nots is getting worse all of the time, and that's not good. They quoted somebody, "That that's the beginning of the end."

Q: Well, you can never tell.

A: But I don't know how I got on to that.

Q: Well, if you have nothing else, I'd like to thank you for your time.

A: You're certainly welcome. I've enjoyed our conversations.

Appendix A

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
TECHNICAL LIAISON OFFICE
Room 1031, Bldg. T-7, Gravelly Point, Washington, D. C. 20315
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FOR IMMEDIATE RELEASE

December 29, 1966

FRANKLIN F. SNYDER RETIRES
FROM ARMY ENGINEERS

Franklin F. Snyder, Assistant Chief of the Hydrology and Hydraulics Branch and Special Engineering Consultant to the Chief of the Engineering Division, Civil Works, in the Office of the Chief of Army Engineers is retiring at the end of December after 30 years of Federal service, 24 years of which were with the Corps of Engineers.

Mr. Snyder has served in his present position since 1956. In this capacity he has represented the Corps of Engineers on inter-agency, national and international committees. Much of his time has been spent on studies in connection with the St. Lawrence Seaway and Power Project for the International Joint Commission and he has served on the International St. Lawrence River Board of Control since 1961.

From December 1944 through May 1945, Mr. Snyder served as Technical Representative in the European Theatre of operations, developing the necessary forecasting relationships and preparing twice daily forecasts of Rhine River stages for information of the allied armies. He received the Army Exceptional Civilian Service Award for his contribution to the success of the Rhine River Flood Prediction Service.

Prior to his service with the Corps of Engineers, Mr. Snyder served as hydraulic engineer with the U.S. **Geological Survey**, the Tennessee Valley Authority, the U.S. Weather Bureau and the State of Pennsylvania.

Mr. Snyder received a BCE in 1932 and a C.E. **degree** in 1942 from Ohio State University. He is the author of papers on various phases of hydrology and co-author of a paper on Flood Routing which was awarded the J. James R. Croes medal of the ASCE for 1940. He has consulted on spillway requirements for dams in Mexico, the Sudan Colombia and British Columbia.

Mr. Snyder **is** a member of the Cosmos Club, Tau Beta Pi, Sigma Xi, a fellow of the American Society of Civil **Engineers** member of the American Geophysical Union **and** the American Meteorological Society, and a registered professional engineer.

After retirement Mr. Snyder will practice as a consulting hydrologic engineer.

Mrs. Snyder is the former Mary Elizabeth Bruton of Delaware County, Pennsylvania. Mr. and Mrs. Snyder have three children: Mrs. Marilyn K. Stack of Arlington, Carol, and Gregory.



Office of History
U.S. Army Corps of Engineers
